

# Chapter 6

## Wireless Access in Vehicular Environments

**Tzong-Jye Liu**

*Feng Chia University, Taiwan, R.O.C.*

**Ching-Wen Chen**

*Feng Chia University, Taiwan, R.O.C.*

### ABSTRACT

*The IEEE 1609 standards define communication for wireless access in vehicular environment (WAVE) services, which enable vehicle-to-vehicle, vehicle-to-roadside, as well as vehicle-to-infrastructure communications. The standard consists of four parts, which are briefly described in this chapter. IEEE 1609.1 describes the WAVE resource manager which specifies the wireless access method in a WAVE environment and allows a remote manager application to establish connection with a resource command processor on an on-board unit. IEEE 1609.2 defines several secure message formats to process messages for WAVE system. The standard covers methods for securing WAVE management messages and application messages, which protects messages from attacks such as eavesdropping, spoofing, alteration, replay, and linkable information to unauthorized parties. IEEE 1609.3 defines network services for WAVE systems, whose network services operate at the network and transport layers of the OSI model and support both the IPv6 traffics and the WAVE short message services. IEEE 1609.4 describes WAVE multi-channel operations. It specifies the functions of MAC sublayer management entity and WAVE MAC with channel coordination. The multi-channel operation provides an efficient mechanism that controls the operation of upper layer across multiple channels.*

### INTRODUCTION

The IEEE 1609 standards (IEEE 1609.1<sup>TM</sup>, 2006; IEEE 1609.2<sup>TM</sup>, 2006; IEEE 1609.3<sup>TM</sup>, 2007; IEEE 1609.4<sup>TM</sup>, 2006) define communication for

wireless access in vehicular environment (WAVE) services, which enable vehicle-to-vehicle, vehicle-to-roadside, as well as vehicle-to-infrastructure communications. The standard consists of four parts, which are briefly described in this chapter. IEEE 1609.1 (IEEE 1609.1<sup>TM</sup>, 2006) describes the WAVE resource manager which specifies the wire-

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less access method in a WAVE environment and allows a remote manager application to establish connection with a resource command processor on an on-board unit. IEEE 1609.2 (IEEE 1609.2™, 2006) defines several secure message formats to process messages for WAVE system. The standard covers methods for securing WAVE management messages and application messages, which protects messages from attacks such as eavesdropping, spoofing, alteration, replay, and linkable information to unauthorized parties. IEEE 1609.3 (IEEE 1609.3™, 2007) defines network services for WAVE systems, whose network services operate at the network and transport layers of the OSI model and support both the IPv6 traffics and the WAVE short message services. IEEE 1609.4 (IEEE 1609.4™, 2006) describes WAVE multi-channel operations. It specifies the functions of MAC sublayer management entity and WAVE MAC with channel coordination. The multi-channel operation provides an efficient mechanism that controls the operation of upper layer across multiple channels.

This chapter describes the standards for the wireless access in vehicular environment (WAVE). The IEEE 1609 standards define communication for WAVE services, which enable vehicle to vehicle (V2V), vehicle to roadside, and vehicle to infrastructure (V2I) communication. The communication system integrates the information of engine, gearing, brake, roadside unit, and provides safety services for drivers. In the standard, the specification of the physical layer is defined in IEEE 802.11p and the communication protocol for WAVE network service is IPv6. This chapter also describes the four parts of the IEEE 1609 standards. Section 6.2 describes IEEE 1609.4 (2006), the functions of MAC sublayer management entity (MLME) and WAVE MAC with channel coordination are introduced. Section 6.3 describes the IEEE 1609.3 (2007), the WAVE network services for WAVE systems are introduced. Section 6.4 describes the IEEE 1609.2 (2006), the secure message formats and the process of the secure

messages for DSRC/WAVE system are defined. Section 6.5 describes the IEEE 1609.1 (2006), the WAVE resource management is introduced.

## **WAVE MULTI-CHANNEL OPERATIONS**

IEEE 1609.4 (2006) describes WAVE multi-channel operations. It specifies the functions of MAC sublayer management entity (MLME) and WAVE MAC with channel coordination. Multi-channel operation provides an efficient mechanism that controls the operation of upper layer across multiple channels. The channel coordination enhances the mechanism defined in the MAC of IEEE 802.11 and interacts with IEEE 802.2 logical link control and IEEE 802.11p PHY.

WAVE devices (on-board units or roadside units) provide an architecture that supports a single control channel (CCH) and multiple service channels (SCHs). The control channel is for transmitting WAVE short message and announcing WAVE services. The service channels are for interactions and transmissions between applications. WAVE standard uses the specification of the PHY in IEEE 802.11 and revises to IEEE 802.11p.

The services defined in IEEE 1609.4 (2006) are for managing the channel coordination and supporting MAC service data unit (MSDU) delivery. The services include the channel routing, user priority, channel coordination and MAC service data unit transfer. In the following of this section, we will describe these four services.

### **The Channel Routing**

WAVE supports both the WAVE short message (WSM) and IP datagram transfer. When an MSDU is passed from the LLC to the MAC, the MAC determines whether the MSDU is a WSM or an IP datagram by checking the EtherType field in the MSDU. If the value of this field is 0x86DD, an IPv6 header follows. If the value is 0x88DC,

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